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Claims

1. A scotch yoke fluid device which includes:

a crank including a big end having an axis which orbits about a main axis for the crank;

connecting means mounted on the big end axis;

at least one piston mounted for reciprocal motion in a cylinder along a piston axis, the piston having a cross-sectional area perpendicular to the piston axis, the piston having guide means including a linear surface transverse to the piston axis, the guide means engaging engagement means on the connecting means; and

at least one restricting means for constraining the piston to move along the piston axis;

wherein the piston guide means bisects the piston cross-sectional area and at least part of each restricting means is located within a volume defined by the piston cross-sectional area projected along the piston axis, but is not located along the centre line of the bisection formed by the piston guide means.

2. The device of claim 1, wherein the guide means includes surfaces which extend substantially perpendicularly to the respective piston axis.

3. The device of claim 1 or 2, wherein the restricting means includes a pair of members and a line drawn from one member to the other of the pair is perpendicular to the center line of the bisection of the piston formed by the piston guide means.

4. The device of claim 1 or 2 wherein the restricting means includes a member which is located on either side of the bisection formed by the piston guide means but not along the center line.

5. The device of claim 1 or 2, wherein each piston has the restricting means formed integrally therewith.

6. The device of claim 1 or 2, wherein each piston has the restricting means formed separately from and mounted on the piston.

7. The device of any one of claims 1 to 6, wherein the restricting means is slideably engaged in one or more slideways mounted on a block for the device.

8. The device of any one of claims 1 to 7, wherein there are two, three, four, five or six pistons.

9. The device of claim 8, wherein each piston has two restricting means which are located symmetrically relative to the piston axis.

10. The device of any one of claims 1 to 7, wherein there are least two such pistons, and wherein the guide means of the pistons are disposed on the same side of the big end axis.

11. The device of any one of claims 1 to 10, wherein the guide means engages the engagement means on the connecting means by sliding.

12. The device of any one of claims 1 to 11, wherein as the crank rotates, at least one restricting means extends into a volume defined by the swept area of the crank projected along the main axis of the crank.

13. The device of any one of claims 1 to 12, wherein the linear surface is in a plane which is perpendicular to the respective piston axis.

14. The device of any one of claims 1 to 12, wherein the linear surface is in a plane which is other than 90° to the respective piston axis.

15. The device of claim 13 or 14, wherein the engagement means includes two or more parallel linear surfaces which correspond and slide relative to the guide surfaces.

16. The device of any one of claims 1 to 14, wherein the linear surface and/or the engagement means includes two or more roller bearings and the guide means engages the engagement means on the connecting means by sliding.

17. The device of claim 15, wherein the linear parallel opposed guide surfaces are located on the connecting means and the engagement means are mounted on the piston.

18. The device of claim 10, wherein there are two or three pistons mounted on slider means on each big end axis.

19. The device of claim 10, wherein the pistons are arranged at equal angles about the main axis.

20. The device of claim 10, wherein the guide means is integral with the piston.

21. The device of claim 10, wherein the guide means is located on a separate structure mounted on the piston.

22. The device of claim 21, wherein the separate structure is pivotably mounted to the piston.

23. The device of claim 1 or 10, wherein the main axis of the crank is fixed relative to the or each cylinder.

24. The device of claim 1 or 10, wherein the main axis of the crank is movable relative to the or each cylinder, so as to alter the compression ratio and/or the timing of each piston in each cylinder.

25. The device of claim 1 or 10, wherein the main axis of the crank is movable relative to the or at least one cylinder, wherein such movement results in a change in compression ratio without any change in phase.

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26. The device of claim 1 or 10, wherein the main axis of the crank is rotatable relative to the or each cylinder about an axis remote from the main axis, so raising or lowering the crank relative to the or each cylinder.

27. The device of claim 1 or 10, wherein the crank is moveable in a plane perpendicular to the or at least one piston axis.

28. The device of claim 1, wherein the connecting means has a non-rotary movement relative to the piston and the device including stabilising means engaging the connecting means to limit the connecting means to a single orientation as it orbits the main axis.

29. The device of claim 28, wherein the stabilising means includes engagement of the connecting means with the piston.

30. The device of claim 28, wherein the stabilising means includes a separate linkage pivotably mounted to both the connecting means and a crankcase for the device.

31. The device of claim 1, wherein the main axis of the crank is moveable along at least one path relative to the cylinder and the engagement means is configured such that the piston is neither substantially retarded nor advanced when the main axis of the crank is moved along said path.

32. The device of claim 31, wherein the main axis of the crank moves along a linear path.

33. The device of claim 31, wherein the main axis of the crank moves along an arc.

34. The device of claim 1, wherein the connecting means has a center of mass located on or adjacent to the big end axis.

35. The device of claim 34, wherein the crank includes a counter weight which substantially and/or dynamically balances the mass of the connecting means relative to the main axis.

36. The device of claim 1, wherein the crank has an effective center of mass which, together with the connecting means and the or each piston, remains stationary or substantially stationary relative to the main axis as the crank rotates.

37. The device of claim 1, wherein the device has at least two such pistons, wherein the configuration of the connecting means and the engagement means is such that the motion of each piston is simple harmonic motion.

38. The device of claim 1, wherein the device has at least one pair of such pistons, wherein each pair of pistons has a mass the motion of which is equivalent to a single mass orbiting in an orbit.

39. The device of claim 38, wherein the orbit is a circle.

40. The device of claim 38, wherein the orbit is an ellipse.

41. The device of claim 38, wherein the motion of each of the pistons is simple harmonic motion.

42. The device of claim 1, wherein the big end and the connecting means are combined in the form of a circular cam.

43. The device of claim 42, wherein there are two such pistons.

44. The device of claim 43, wherein the piston axes are at an angle to each other.

45. The device of claim 44, wherein the angle is 60°, 72°, 90°, 120° or 180°.

46. The device of claim 1, which includes means for adjusting the distance between the piston and the engagement means.

47. The device of claim 46 wherein the means for adjusting includes a connecting rod mounted to the piston and the engagement means.

48. The device of claim 1, wherein, at top dead centre, the main axis lies between the piston and the big end axis.

49. The device of claim 1, wherein, when the piston is at top dead centre, a line joining the main and big end axes is parallel to and spaced from the piston axis.

50. The device of claim 49,wherein when the or one of the pistons is at top or bottom dead centre a line joining the main and big end axes is parallel to and spaced from the respective piston axis of the one piston.

51. A piston-type fluid device which includes:

a crank having a main axis and including a big end member having an axis which rotates about the main axis;

at least one piston arrangement having at least one piston mounted for reciprocal motion in a cylinder along a piston axis, the piston having a cross-sectional area perpendicular to the piston axis;

at least one follower located between the member and the piston for transferring motion of the member to the piston, the follower reciprocating along a linear path, having a centre line, between two end points; and

at least one restricting means for constraining the piston to move along the piston axis;

wherein at least part of each restricting means is located within a volume defined by the piston cross-sectional area projected along the piston axis, but is not located on the centre line between the two end points.

52. The device of claim 51, wherein each piston arrangement has two surfaces.

53. The device of claim 52, wherein there is a single follower for each piston and the follower bears on both surfaces.

54. The device of claim 52, wherein the member bears on one surface and the follower on the other surface.

55. The device of claim 52, wherein there are two followers, each of which bears on one of the respective surfaces.

56. The device of claim 51, wherein each piston arrangement has one piston.

57. The device of claim 51, wherein each piston arrangement has two pistons.

58. The device of claim 51, wherein each piston arrangement has two pistons and one follower located between the two pistons.

59. The device of claim 51, wherein the follower is a circular cam having its centre offset from the main axis.

60. The device of claim 51, wherein there are two or more piston arrangements for each big end member.

61. The device of claim 51, wherein there are two piston arrangements, the piston axis of one piston in the first arrangement being at an angle to the piston axis of one piston in the second arrangement.

62. The device of claim 51, wherein the angle is 90°.

63. The device of claim 62, wherein there are two followers, each of which engages pistons in both piston arrangements.

64. A fluid device, which includes:

a crank including a big end having an axis which orbits about a main axis for the crank;

connecting means mounted on the big end axis;

at least one pair of pistons, each piston being mounted for reciprocal motion in a respective cylinder along a respective piston axis, the piston axes of each pair being at 90° to each other, each piston engaging engagement means on the connecting means;

wherein each pair of pistons has a mass the motion of which is equivalent to a single mass orbiting in an orbit;

the centre of mass of the connecting means is located on or adjacent the big end axis; and

the crank includes a counter weight located generally diametrically opposite the big end and a centre of mass remote from the crank axis, the counter weight including the equivalent of:

a first mass to statically and/or dynamically balance all or part of the mass of the big end bearing relative to the crank axis;

a second mass to statically and/or dynamically balance all or part of the mass of the connecting means relative to the crank axis; and,

a respective third mass to statically and/or dynamically balance all or part of the mass of each pair of pistons relative to the crank axis.

65. The device of claim 64 wherein the orbit is a circle and the third mass preferably statically and/or dynamically balances the mass of the pistons.

66. The device of claim 64 wherein the orbit is not a circle and the third mass balances the mass of the pistons in a first direction.

67. The device of claim 66 wherein the first direction is parallel or perpendicular to a bisector of the axes of each pair of pistons.

68. The device of claim 64 including means to substantially prevent rotary motion of the connecting means relative to the piston.

69. A fluid device, which includes:

a crank including a big end having an axis which orbits about a main axis;

connecting means mounted on the big end axis;

at least one piston mounted for reciprocal motion in a cylinder along a piston axis;

intermediate connecting means interconnecting the at least one piston with the connecting means; and

means for adjusting the position of the intermediate connecting means relative to the at least one piston or the connecting means or both.

70. The device of claim 69 wherein the means for adjusting includes a slot, groove or surface which engages the intermediate connecting means.

71. The device of claim 70 wherein the intermediate connecting means engages in or with guide means to stabilise the at least one piston in the cylinder.

72. The device of claim 71 wherein the means for adjusting includes the guide means.

73. The device of claim 71 wherein the guide means are separate from the means for adjusting.

74. The device of claim 69 wherein the means for adjusting is movable transversely or longitudinally relative to the cylinder axis or both.

75. The device of claim 71 wherein the guide means is rotatable about an axis.

76. The device of claim 69 wherein the means for adjusting includes a linear, single radius curved or multi-radius curved slot/s, groove/s, surface/s or the like or any combination of the foregoing.

77. The device of claim 69 wherein the intermediate means includes sliding or rolling contact members to engage the means for adjusting.

78. The device of claim 69 wherein the means for adjusting is movable to change the effective stroke of the pistons, the effective compression ratio of the device or the position/time path followed by the pistons or a combination of any of the foregoing.

79. A yoke assembly for a scotch yoke type fluid device having opposed pistons reciprocating in opposed cylinders having parallel cylinder axes, the yoke assembly mounted on the two pistons and including an engagement portion for receiving an engagement member rotatably mounted on a big end of a crank shaft and in which the engagement member reciprocates as the crank rotates, said engagement portion being split into two parts.

80. The yoke assembly of claim 79 wherein the engagement portion includes two parts joined together along a plane generally parallel to the cylinder axes or a plane generally perpendicular to the cylinder axes.

81. The yoke assembly of claim 80 wherein the two parts are identical.

82. The yoke assembly of claim 80 wherein only two fixings are required to securely hold the two parts together.

83. The yoke assembly of claim 79 wherein the engagement portion includes two surfaces forming a channel in which the engagement means reciprocates.

84. The yoke assembly of claim 83 when dependent on claim 92 wherein each channel is defined by only one of the parts.

85. The yoke assembly of claim 80 wherein each part includes legs which extend and engage the other part.

86. The yoke assembly of claim 80 including legs located at the ends of the channel.

87. The yoke assembly of claim 80 including a leg positioned adjacent the channel at a mid-point.

88. A piston arrangement for a fluid device, the arrangement including :

a piston mounted for reciprocal motion in a cylinder along a piston axis, the piston having a cross-sectional area perpendicular to the piston axis, the piston having guide means including a linear surface the plane of which is transverse to the piston axis, the guide means adapted to engage engagement means on a connecting means mounted on a big end axis; and

at least one restricting means for constraining the piston to move along the piston axis;

wherein the piston guide means bisects the piston cross-sectional area and at least part of each restricting means is located within a volume defined by the piston cross-sectional area but not along the centre line of the bisection formed by the piston guide means.

89. The arrangement of claim 88, wherein the linear surface includes two or more rollers.

90. The arrangement of claim 88 or 89, wherein the restricting means are integral with the piston.

91. A scotch yoke fluid device which includes:

a crank including a big end having an axis which orbits around and is parallel to a main axis for the crank;

at least one piston arrangement which includes:

a piston mounted for reciprocal motion in a cylinder along a piston axis which is in a plane substantially perpendicular to the big end axis and the main axis, the piston having a cross-sectional area which is perpendicular to the piston axis; and

a scotch yoke element chosen from the group comprising a channel, a rail, a channel and a rail, a bore and a bore and a rail, the element defining a longitudinal path, the big end reciprocating along the path relative to the piston between two end points, the scotch yoke element being integral with the piston or connected thereto via connecting rod means; and

restricting means adapted to move along a defined path and to constrain one or more of the piston, the scotch yoke element and the connecting rod means to move along the defined path,

characterised in that at least part of the restricting means is located transversely of the longitudinal path of the scotch yoke element and within a volume defined by the piston cross-sectional area, projected along the piston axis.

92. The device of claim 91, wherein the restricting means includes a pair of members, one of which is located on an opposite side of the scotch yoke element to the other.

93. The device of claim 92, wherein the members lie on a line which is perpendicular to the longitudinal path.

94. The device of claim 91, wherein there are two pistons, each reciprocating in a dual chambered cylinder closed at each end, a combustion chamber being defined between each piston and the cylinder end.

95. The device of claim 91, wherein there are two pistons for each big end, the piston axis of one piston being in a plane different from that of the other piston.

96. The device of claim 95, which includes at least one lubrication duct to supply lubricant to the scotch yoke element.

97. The device of claim 13 or 14, wherein the linear surface and/or the engagement means includes two or more roller bearings and the guide means engages the engagement means or the connecting means by rolling or by both rolling and sliding.

98. The device of claim 91, wherein there are two cylinders and the main axis is adapted to be moved towards or away from the cylinders.

99. The device of claim 91, which further includes a slave crank having an axis which is parallel to the main axis to stabilise the device.

100. The device of claim 91, which includes a further crank, the two cranks being joined by means to cause the cranks to rotate together.

101. The device of claim 100, wherein the means joining the cranks are gears.

102. The device of claim 91, wherein there are two pistons arranged in a pair, both pistons being positioned in a common plane perpendicular to the crank.

103. The piston arrangement of claim 88, wherein the linear surface extends diametrically through the cross-sectional area.

104. The piston arrangement of claim 88, wherein the linear surface is provided with lubrication by lubrication means.

105. The device of claim 91, wherein the restricting means includes a web which has a cross-sectional shape chosen from the following: square, rectangular, elliptical, circular, arcuate, undulating, mushroom, rod and "F".

106. The device of claim 91, wherein the restricting means has a length which extends above and below the scotch yoke element.

107. The device of claim 91, which includes second restricting means being part of, mounted on or connected to the scotch yoke element and adapted to constrain the scotch yoke element to move along the longitudinal path.

108. The device of claim 107, wherein the second restricting means is adapted to pivot.

109. The device of claim 1 or 91, wherein the or each piston is mounted on an axis which is different from but perpendicular to the main axis.

110. The device of any one of claims 1, 51, 64, 69 or 91 wherein the motion of the or each piston is simple harmonic motion.

111. The device of claim 47, wherein the means for adjusting is pivotably mounted to the piston or the engagement means.

112. The device of claim 95, wherein the two pistons lie in a single plane.

113. The device of claim 100, wherein the means joining the cranks is a connecting means pivotably mounted to the big end of each crank.

114. The device of claim 1, wherein the restricting means has a length which extends above and below the linear surface.

115. The device of any one of claims 1, 51, 64, 69 or 91, wherein the device is part of an engine or pump.

116. The device of any one of claims 1, 51, 64, 69 or 91, wherein the restricting means is restrained by means located in a volume defined by the area swept by the crank projected along the main axis of the crank.

117. The device of claim 1 or 91 wherein there are two big ends, each having a big end axis, an angle D is formed between the first big end axis, the main axis and the second big end axis, the angle D being 0° or more, and wherein there are two piston arrangements, a first piston arrangement being on the first big end and the second piston arrangement being on the second big end, the first piston arrangement having a first piston axis and the second piston arrangement having a second piston axis, the angle between the first piston axis and the second piston axis being A, wherein, in balancing the device, the angle D is set at 2(A-90) degrees.

118. A piston-type fluid device, substantially as herein described, with reference to the drawings.

119. A yoke assembly for a scotch yoke type fluid device, substantially as herein described, with reference to the drawings.

120. A piston arrangement substantially as herein described with reference to the drawings.